DECEMBER 2019

Missouri Forest Health 2019 Update

From the Missouri Department of Conservation

Forest Health Program

INSIDE THIS ISSUE:

Serving nature and you

Floods Impact Bottomland Forests Statewide

Trees in Missouri's bottomland forests were stressed this year by record flooding across the state. Snowmelt and heavy spring rains throughout the central US caused crop fields and forests in some parts of Missouri to be underwater for months. Flooding was especially severe along the Missouri and Mississippi Rivers, the Grand River in north-central Missouri, and areas surrounding Harry S. Truman Reservoir in southwest Missouri. High waters impacted approximately 200,000 acres of forests, causing mortality, discoloration of foliage, and uprooting of trees.

While bottomland tree species can tolerate more flooding than their upland counterparts, this year's excessive rains will leave many trees dead, stressed, or struggling for the next few years. Two of the most flood-tolerant tree species in Missouri, black willow (*Salix nigra*) and eastern cottonwood (*Populus deltoides*) suffered the least from the high waters. However, even these species were impacted by the floods, as yellowing foliage could be seen in low lying areas where flood waters remained high throughout much of the growing season. Tree stress and mortality were more obvious in bottomland species with lower flood tolerance such as pin oak (*Quercus palustris*), silver maple (*Acer saccharinum*), and American sycamore (*Platanus occidentalis*).

Continued on page 2 ⇨

Strong flood currents of the Mississippi River uprooted and toppled many trees in the Upper Mississippi River Conservation Area. *Photo: MDC*

Floods Impact Bottomland Forests Statewide (*continued*)

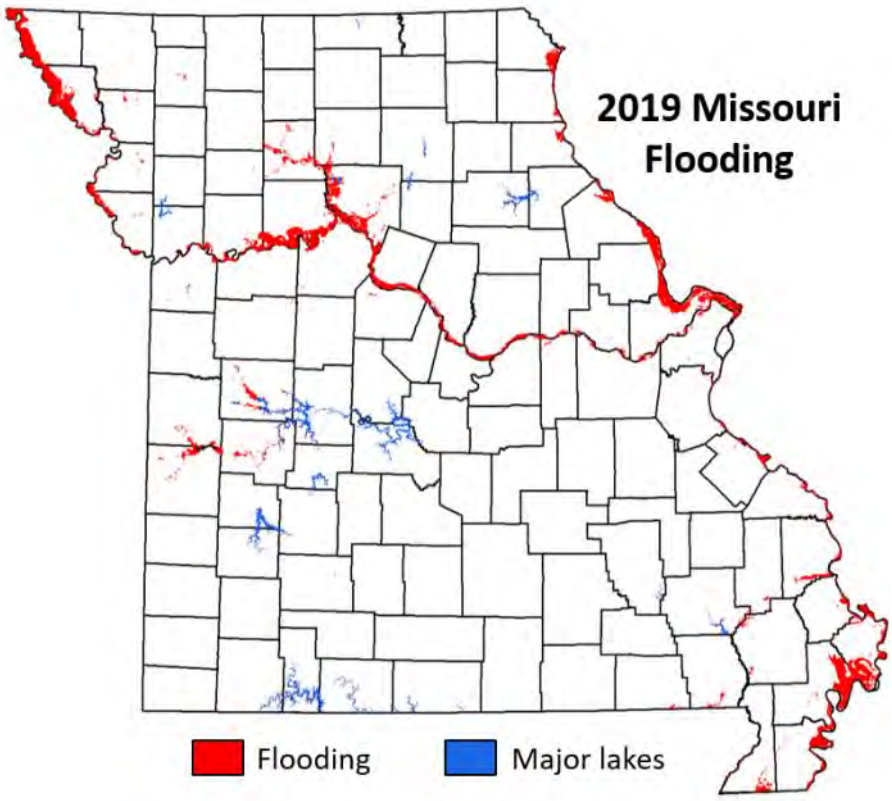
Silver maples in a lower position (right) experienced standing flood water for several weeks. *Photo: MDC*

Flooding harms trees in several ways. The amount of oxygen available to tree roots is greatly reduced in flooded soils. Under low oxygen conditions, tree growth slows, roots die, and toxic compounds can accumulate. These effects are more severe when tree root zones are under water for several weeks during the growing season. Flooding is especially deadly to smaller trees that are entirely covered by water.

Trees are also damaged by the physical effects of floodwaters. Strong currents have the force to topple trees, especially when river levels are high. Currents can carry debris in the form of ice, downed trees, and manmade materials, creating wounds on standing trees. Soil levels may also drastically change, burying tree roots in several inches of silt and sand.

If trees survive the immediate effects of saturated soils and the strength of the current, they still have a challenge ahead of them. Roots are prone to root rot infections, and stem wounds created by flood debris are often entry points for decay fungi. Flood-stressed trees are also easy targets for insect pests and other diseases. Many trees that survived the flood may still decline and die over the next several years from these pressures.

Fortunately, floodplain tree species are quick to recolonize these flood-disturbed areas. Some places impacted by flooding are already filled with cottonwood and silver maple seedlings. As trees impacted by flood decline and die over the next few years, a new cohort will take their place.



Flooding can deposit large amounts of sediment on the root systems of established trees. *Photo: MDC*

Emerald Ash Borer Widespread Across Missouri

The emerald ash borer (EAB), *Agrilus planipennis*, is an invasive beetle that has killed millions of ash trees in North America. It was initially discovered in the Detroit, Michigan area in 2002, but EAB likely entered that region at least a decade earlier via wood pallets and crating from China. EAB has now been detected in 35 US states and five Canadian provinces, stretching its range from Manitoba to Texas and Colorado to Maine.

Missouri's first detection of EAB came in 2008 in Wayne County, near Lake Wappapello. By December 2019, 75 Missouri counties and the city of St. Louis are known to have EAB infestations. Fifteen new county detections occurred during 2019: Benton, Boone, Cooper, Douglas, Holt, Howard, Howell, Linn, Montgomery, Morgan, Nodaway, Ozark, Pettis, Putnam, and Randolph.

The Missouri Department of Agriculture monitored 275 purple prism traps in 25 counties throughout the state in 2019. Trap locations included high-risk areas like campgrounds and municipal yard waste facilities. EAB was captured on traps in ten counties this year—an indication that the EAB population is on the rise in many areas across the state.

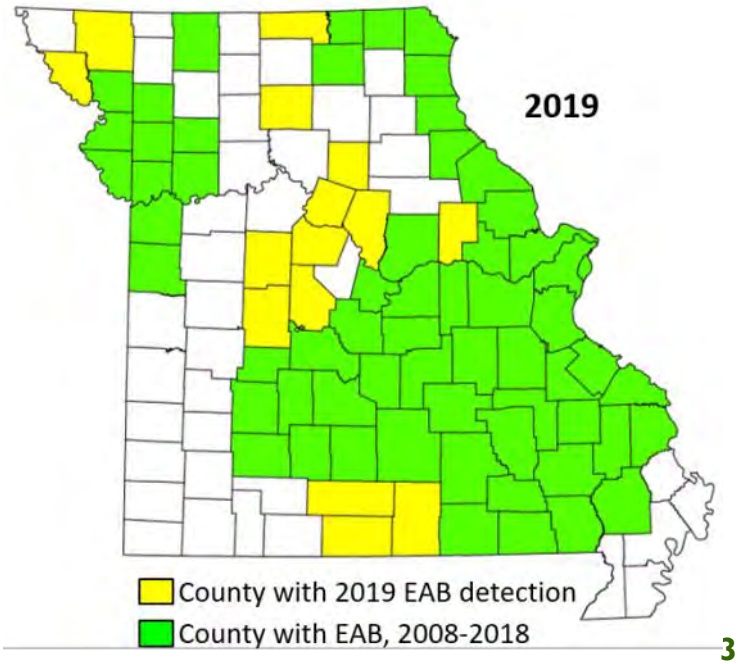
The remaining five new EAB county detections in 2019 were due to USDA APHIS and Missouri Department of Conservation staff observing bark blonding on ash trees. This bark damage is caused by woodpeckers searching for insect larvae inside trees, which pops off the trees' outer bark and reveals highly noticeable, light-colored inner bark. Look for ash trees with bark blonding in late winter or early spring. Please report suspected EAB infestations if the location is in a new county where EAB has not yet been found.

Bark blonding on ash trees is often a sign of EAB infestation.
Photo: MDC, Tyler Cooper

EAB populations can expand slowly on their own to new areas, but the primary way that EAB spreads over long distances is by hitchhiking on ash firewood. To slow the spread of EAB and other invasive forest pests, don't move firewood. Buy it as close as possible to the location you plan to burn it, or harvest firewood on site, if permitted.

Options are available to protect healthy, high-value ash trees from EAB. Please see details in the "**Emerald Ash Borer Management Guide for Missouri Homeowners**." For more information or to report possible EAB, visit **eab.missouri.edu**.

EAB larvae form winding S-shaped feeding galleries.
Photo: Edward Czerwinski, Ontario Ministry of Natural Resources



Thousand Cankers Disease of Black Walnut

Thousand cankers disease (TCD) has been a concern for Missouri's native black walnut population since 2008, when the disease was first discovered in Colorado. TCD is caused by the tiny walnut twig beetle, *Pityophthorus juglandis*, and the fungus it carries to walnut trees, *Geosmithia morbida*. This fungus causes small cankers to form in the phloem tissue under the bark of black walnut. When combined with the feeding activity of thousands of walnut twig beetles, trees begin to decline and eventually die. While *G. morbida* was recently found on several other walnut-feeding insects, the walnut twig beetle has not yet been detected in Missouri, and the state is not known to have TCD.

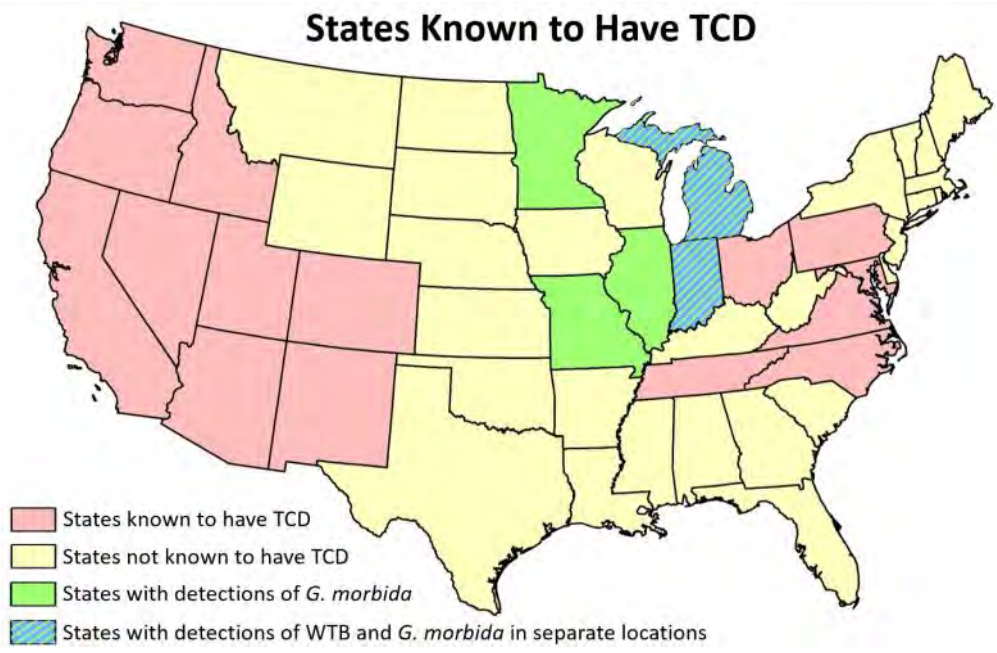
Symptoms of TCD include wilted foliage and branch dieback. *Photo: Karen Snover-Clift, Cornell University, Bugwood.org*

G. morbida was detected in Missouri in 2018 as the result of a cooperative research project between the Missouri departments of Agriculture (MDA) and Conservation (MDC) and the University of Missouri Plant Diagnostic Clinic with funding provided by the US Department of Agriculture's Farm Bill program. Using genetic analysis, *G. morbida* was found on several walnut-feeding beetle species (both native and exotic) in 38 Missouri counties. Detections in our state, as well as other eastern states, suggest that *G. morbida* is a common, widespread, and potentially native species and that the walnut twig beetle is likely the primary damaging agent of TCD.

There is concern that undetected walnut twig beetle infestations could be present in Missouri, or that spread may occur when infested walnut wood is moved from other states, especially those where TCD has been detected (see map below). The Missouri Department of Agriculture has enacted a quarantine prohibiting walnut wood products and all firewood from coming into Missouri from states where TCD has been detected. Visit **agriculture.mo.gov/plants/pests/thousandcankers.php** for more information on Missouri's external quarantine.

In Missouri, TCD is unlikely to be detected until several years after introduction, making reports of walnut tree dieback and decline very important. Visit **treepests.missouri.edu** for more information on what to look for and how to report a suspect tree.

Adult walnut twig beetles within galleries in walnut bark. *Photo: MDC*

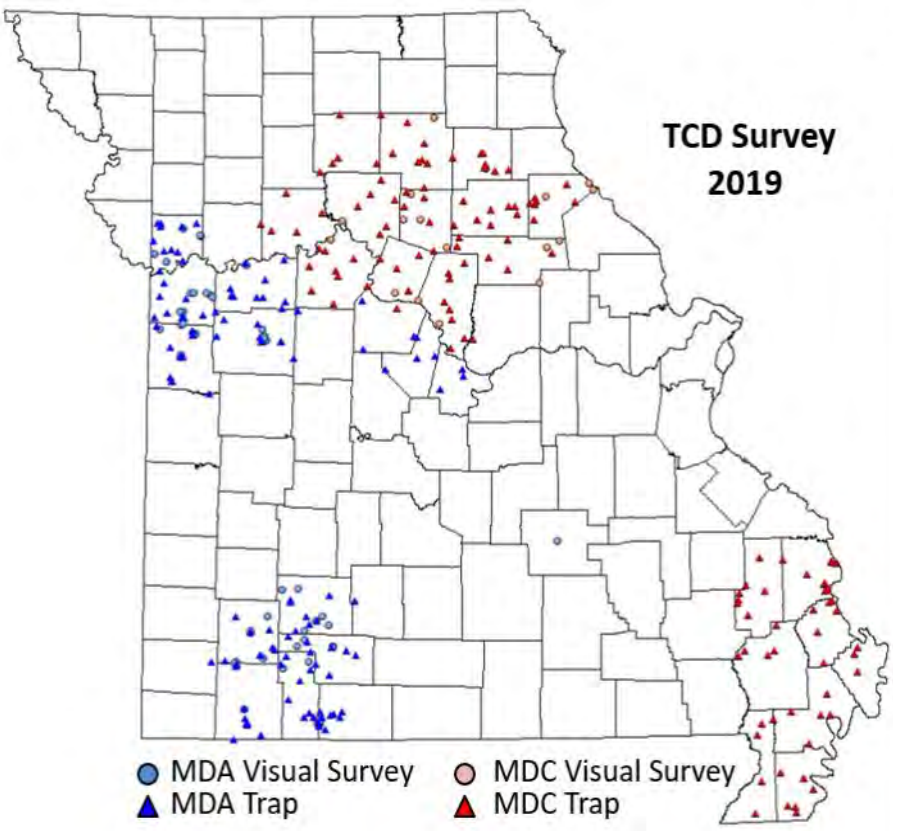


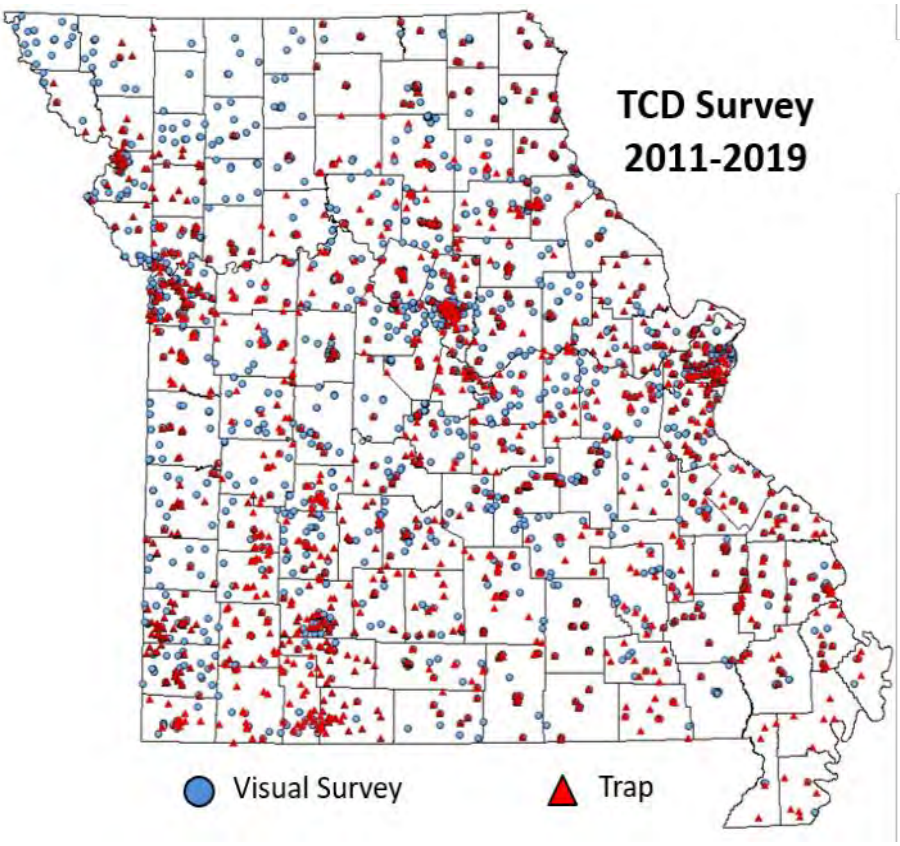
2019 Thousand Cankers Disease Survey

In 2019, MDC and MDA conducted surveys for TCD using USDA Forest Service and USDA Farm Bill funding, respectively. Survey activities this year included 238 walnut twig beetle traps in walnut trees or at sawmill log piles, in addition to 306 visual surveys to identify potentially infested trees. Visual surveys were conducted in high-risk locations within 34 counties in central, west-central, southeast, and southwest Missouri. Branch samples were collected from highly suspect trees for lab evaluation and none had any evidence of TCD. Analysis of trap catches is ongoing, but at this time there is no evidence of walnut twig beetle at survey locations. Survey efforts are rotated to different regions each year. Since 2010, there have been 2,875 locations visually surveyed and 1,506 traps deployed.

Since early detection of TCD is difficult, reports of walnut tree dieback and decline are extremely important. Visit the **Missouri Invasive Forest Pest Council** website for more information on what to look for and how to report a suspect tree. Missourians are encouraged to report suspect trees via the online reporting form which can be found linked to the TCD website. Photos of suspect trees can also be emailed to **forest.health@mdc.mo.gov** as a first step in determining what trees should be visited by trained personnel.

Walnut twig beetle trap. *Photo: MDC*





Gypsy Moth Survey: Single Moth Captured in 2019

The multi-agency Missouri Cooperative Gypsy Moth Program conducted its annual survey to detect the presence of gypsy moth (*Lymantria dispar*) by placing and monitoring 6,548 traps in 47 counties. Only one male European gypsy moth was captured statewide in 2019. This moth was found in a trap in St. Louis City. Next summer, the area where the single moth was captured will be intensively surveyed to confirm no breeding populations of gypsy moth are present.

Missouri is not known to have any established populations of gypsy moth. It is very easy, however, to transport gypsy moth egg masses to our state accidentally. People moving to Missouri from gypsy moth-infested states are legally required to examine all outdoor articles for tan, fuzzy egg masses. Please remove these masses before moving items to Missouri.

Gypsy moth egg masses on a tree trunk.
Photo: Karla Salp, WA Dept. of Agriculture, Bugwood.org

Japanese Beetle Numbers Down in 2019

For Missouri residents in the central and western parts of the state, the summers of 2017 and 2018 came with high populations of Japanese beetles. Fortunately, that wasn't the case in 2019. Japanese beetle numbers were much lower, giving home gardens, crop fields, and orchards a break from this pest's destructive feeding.

Weather-related theories were given as to why the Japanese beetle population was down this year; some people thought the bitterly cold winter temperatures likely killed grubs in the soil while others hypothesized that the abundance of rain from late winter through early summer must have drowned larvae. Neither of these theories are correct, as Japanese beetle grubs are well-adapted to handle wet and cold soil conditions (moist soils are preferred; soil temperatures at or below 15°F are needed to kill this species). What likely lowered their numbers was drought—specifically drought during July, August, and September of 2018.

Drought conditions in summer and early fall can lead to the death of many newly hatched Japanese beetle grubs. A study from 1972 found that young grubs are more vulnerable to water loss and need around 10 inches of rainfall during the July to September period to survive (USDA Technical Bulletin #1449). The northern half of Missouri experienced severe to exceptional drought during those months in 2018, so it was no surprise that Japanese beetle populations were widely reduced in 2019.

Japanese beetles feeding on aromatic sumac. *Photo: MDC*

Japanese beetles are capable of entirely defoliating mature trees, leaving behind lacy-looking, skeletonized leaves. Healthy, established trees can typically tolerate a heavy amount of feeding damage. However, this damage stresses trees, and multiple years of defoliation could cause long-term tree health issues. You can help your trees by watering them 2-3 times per month during dry times to avoid additional stress from drought. A good rule of thumb is 10 gallons per inch of a tree's diameter.

If your trees suffered extensive Japanese beetle damage in 2019, consider ways to protect them next summer. Keep an eye out for the beetles starting in early to mid-June. Prevent early feeding damage by handpicking beetles off small or newly planted trees. For more information on treatment options, check out our **Japanese Beetle Forest Health Alert**.

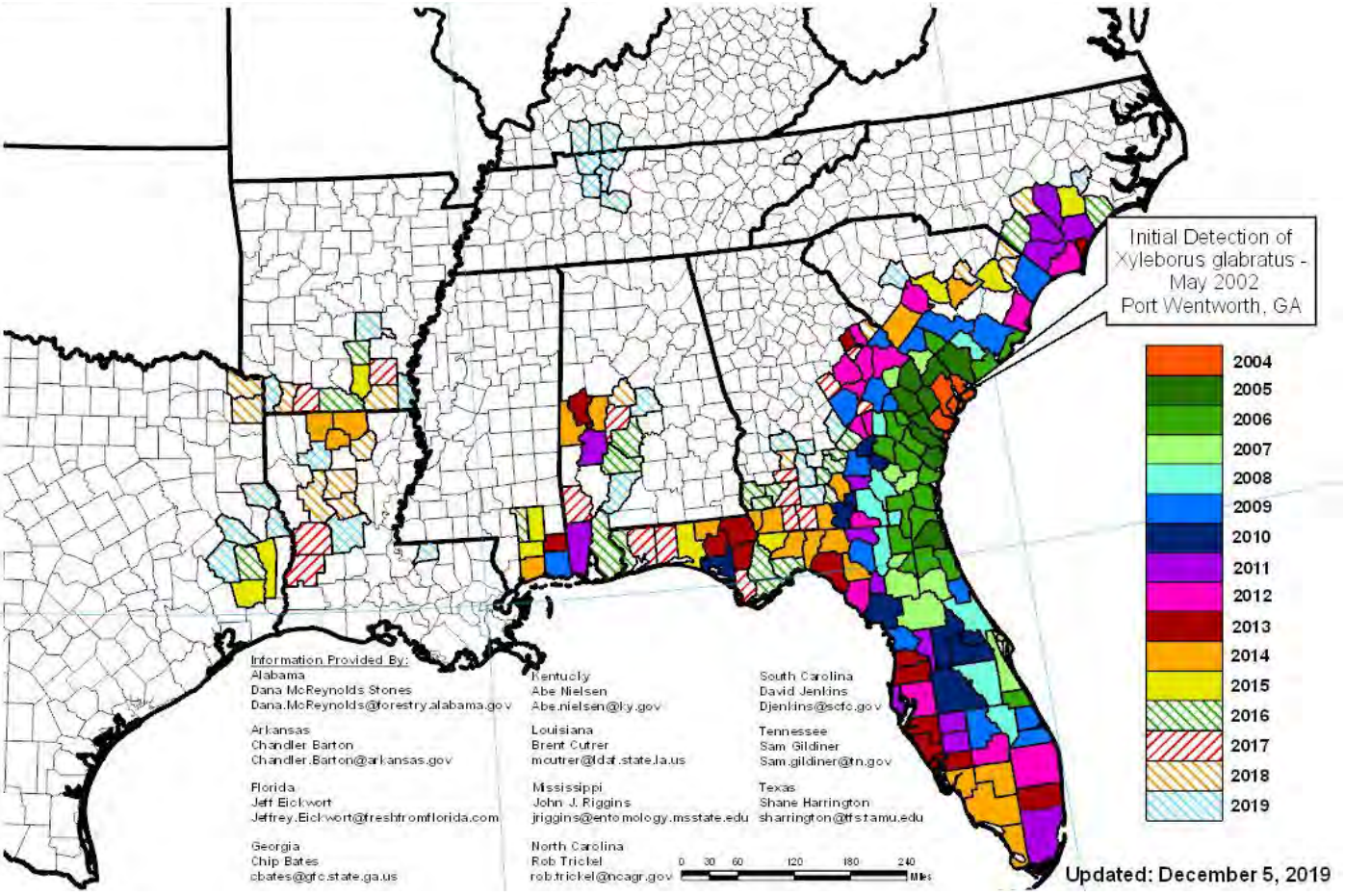
Laurel Wilt Moves Closer to Missouri

In 2019 laurel wilt was detected in several counties in western Kentucky and Tennessee, less than 100 miles from the southeast Missouri border. Laurel wilt is a tree-killing insect and disease complex, which consists of the invasive red-bay ambrosia beetle and its fungal counterpart, *Raffaelea lauricola*. When introduced to trees by the redbay ambrosia beetle, the fungus causes a lethal vascular wilt disease of sassafras and other plants in the Lauraceae family. In addition to killing sassafras, research has shown that spicebush and endangered pondberry are also susceptible to laurel wilt.

Laurel wilt can spread through lateral roots, killing an entire clump of sassafras. *Photo: Chip Bates, Georgia Forestry Commission*

Although laurel wilt has not yet been detected in Missouri, the recent detections in Kentucky and Tennessee mean that this tree-killing pest could arrive at any time. The Forest Health Program asks that Missourians to be on the lookout for dying sassafras. Symptoms include rapidly wilting leaves, which turn reddish-brown and remain attached to the tree, dark staining in the sapwood, and small ambrosia beetle exit holes in the bark. Occasionally frass 'toothpicks' can be found coming out of exit holes. Entire clumps of sassafras may wilt, as the disease can quickly spread through lateral roots to neighboring plants. Report dying sassafras to MDC's Forest Pathologist, Natalie Diesel: **Natalie.Diesel@mdc.mo.gov**.

Distribution of Counties with Laurel Wilt Disease by Year of Initial Detection



Rapid White Oak Mortality

RWOM pocket at Huzzah Conservation Area in Crawford County, MO. *Photo: MDC*

Beginning in 2011, significant white oak mortality has been reported throughout the state, with the greatest number of affected sites occurring in central, east central, and southeast Missouri. Unlike oak decline, which typically affects mature trees in the red oak group, this mortality disproportionately affects white oak and occurs on sites considered favorable for tree growth. Mortality is most significant along drainages and affected white oaks often die rapidly. Consequently, the phenomenon was named rapid white oak mortality (RWOM). Several new reports of RWOM were received in 2019, as well as reports of ongoing mortality at previously established sites.

The University of Missouri recently completed a multi-year research investigation led by Dr. Sharon Reed to study factors causing RWOM and how to better predict and manage affected locations. The research determined that tree mortality is affected by soil characteristics and slope position. RWOM tends to be concentrated on the lower half of slopes in soils that fluctuate between wet and dry conditions. More mortality was observed on soils with a higher soil pH (near neutral) and less than 30% clay. Mortality is not significantly related to age, but large, dominant overstory white oaks in the 10 to 18-inch size class are most affected. The research also suggests that stocking levels, a measure of the number of trees and their size, may not be related to tree mortality.

Investigations of associated insects and diseases resulted in the discovery of *Phytophthora cinnamomi* in several soil samples from Crawford, Shannon, Washington, and Wayne counties. The pathogen was also isolated from the trunk of a white oak in Ste. Genevieve County. *P. cinnamomi* is an exotic root-rot pathogen that has been associated with similar white oak mortality patterns in eastern states. In Crawford and Washington counties, a second exotic fungal pathogen, *Diplodia corticola*, was discovered causing stem and branch cankers on several white oaks. Other commonly detected insects and diseases at RWOM sites included native and non-native species of wood-boring beetles, *Hypoxylon* canker, and *Armillaria* root rot. These pests generally affect stressed and declining trees and aren't typically considered primary causes of tree mortality.

Although there is still a need for further research into RWOM, the University of Missouri investigation suggests that this mortality may be the result of many stressors working together over the course of several years to kill trees. Trees killed by RWOM decay rapidly and should be salvaged soon after death. Forest managers should consider increasing stand diversity and decreasing the percentage of white oaks, particularly on lower slopes and along drainages. Oak regeneration has been observed on affected sites but management of undesirable species may be necessary to maintain an oak component. Good stand management practices are recommended to promote vigor and limit mortality, though they may not prevent RWOM. Landowners and managers are encouraged to report new RWOM events to the MDC Forest Pathologist (**Natalie.Diesel@mdc.mo.gov**; (573) 815-7900 x2946).

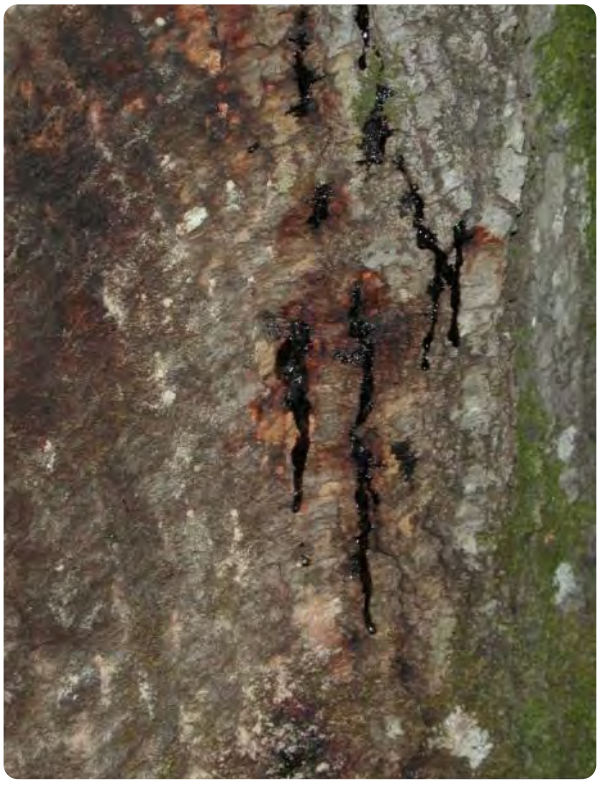
Is Sudden Oak Death in Missouri?

Landscaping plants purchased this year may have been carrying a disease detrimental to Missouri's oak trees and forests. The fungal-like pathogen that causes sudden oak death and ramorum blight – *Phytophthora ramorum* – was detected on rhododendrons and lilacs shipped to Missouri and 17 other states. Wal-Mart and Rural King locations across Missouri, as well as the Springfield Home Depot, Stark Bros. Nursery Garden Center, and the Fort Leonard Wood PX, all received rhododendrons potentially infected with ramorum blight. The plants originated from nurseries in the Pacific Northwest and were brokered through Park Hills Plants in Oklahoma. Unfortunately, many of the potentially-infected plants were already sold by the time the Missouri Department of Agriculture received information on the issue.

News of nursery plants carrying ramorum blight in Missouri is concerning as most of Missouri's trees are oaks. Fortunately, sudden oak death has not been detected on oaks in Missouri to date. To help reduce the potential spread of sudden oak death, consumers who purchased rhododendrons or lilacs labeled Park Hill Plants from the above listed stores between March and June of 2019 should dispose of the plants immediately. If you are unsure of the source of your rhododendron or lilac, watch for symptoms of ramorum blight, which include wilting or browning leaves, leaf spots, and twig dieback. More information on how to properly dispose of plants or report potentially infected plants can be found by visiting the Missouri Department of Agriculture website: **agriculture.mo.gov/plants/suddenoakdeath/**.

Several studies have attempted to determine Missouri's risk of sudden oak death establishing and injuring our oaks. Our climate differs greatly from the cool, wet conditions of the Pacific Northwest, potentially reducing the risk for establishment of this disease. Unfortunately, several of our oak species, particularly those in the red oak group, can serve as hosts for this pathogen, making it possible for sudden oak death to occur in our state.

Sudden oak death was first recognized in the mid-1990s in California and since has killed millions of oak and tanoak trees in California and Oregon. Oaks suffering from sudden oak death develop bleeding trunk cankers that are reddish-brown to black in color and seep dark-colored sap. Infected trees may ultimately experience rapid browning of the entire crown. While ramorum blight is caused by the same pathogen as sudden oak death, this disease affects many species besides oaks, including rhododendrons and lilacs, and appears as leaf spots and twig dieback. Plants with ramorum blight may stay alive for months or years, serving as a source of *Phytophthora ramorum*.



Above: Rhododendron leaf showing symptoms of ramorum blight. *Photo: Joseph OBrien, USDA Forest Service, Bugwood.org*

Left: Trunks of infected oaks develop numerous bleeding cankers that ooze dark-colored sap. *Photo: Bruce Moltzan, USDA Forest Service, Bugwood.org*

Anthracnose Abound in 2019

Cool, rainy weather that lingered throughout the spring and early summer created ideal conditions for anthracnose in 2019. The term anthracnose refers to a set of disease symptoms that are caused by several different pathogens and affect a variety of trees. Severity of disease depends on weather conditions, timing, growth stage and the host species. While anthracnose affects many deciduous trees, oak, sycamore, ash, and maple are most commonly damaged in Missouri.

Oak Anthracnose

Perhaps the most widely reported anthracnose disease in 2019 was anthracnose on oaks. Anthracnose of oaks is typically caused by the pathogens *Apiognomonia quercina* and *A. errabunda*. Many oak species may be infected with anthracnose, and this year species in both the red oak and white oak groups were affected. Symptoms of anthracnose on oaks include leaf and shoot blight, distorted leaves with large dead areas, and brown spots on regularly-shaped mature leaves. Infection often follows major leaf veins. Anthracnose-infected shoots may develop twig cankers and experience some dieback. Trees with severe anthracnose infection typically exhibit a scorched or blighted appearance. While oak anthracnose is generally not a serious issue for healthy oaks, good tree care practices should be used to reduce stress for trees suffering from anthracnose.

Sycamore Anthracnose

This spring, the Forest Health Program observed high levels of sycamore anthracnose, particularly in the central portion of the state. Many heavily affected trees dropped their first flush of leaves and put out a new flush of growth by mid-summer. Sycamore anthracnose is among the more serious of the anthracnose diseases. The pathogen *Apiognomonia veneta* causes leaf and shoot blight, twig cankers, dieback, and even branch deformity over time. Infected leaves display purple-brown lesions along major veins or may be stunted due to cankers in twigs. Repeated loss of buds and twigs due to cankers can cause dieback and deformity of branches. Anthracnose infection of terminal buds even contributes to American sycamore's characteristic right-angle branching pattern.

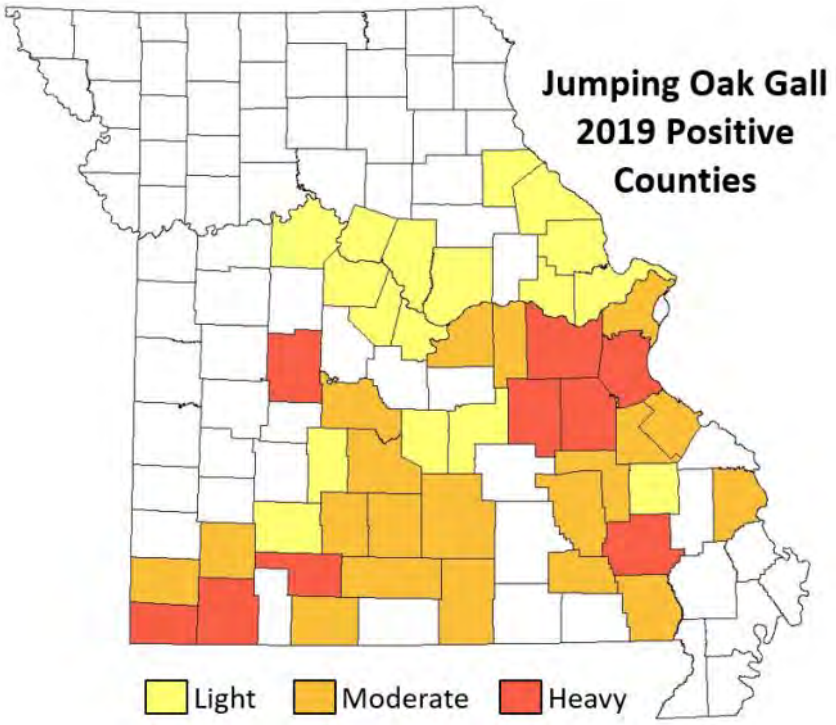
For more information on anthracnose, as well as treatment and care recommendations for diseased trees, visit the **Anthracnose of Shade Trees Forest Health Alert**.

Anthracnose symptoms on oak leaf. *Photo: Penn State Dept. of Plant Pathology & Environmental Microbiology, Bugwood.org*

Sycamore anthracnose causing stunted leaves, twig cankers, and deformed branching pattern. *Photo: MDC (top), W. Jacobi, Colorado State Univ., Bugwood.org (bottom)*

A Good Year for Jumping Oak Gall

Several counties in the southern half of the state reported jumping oak gall on white oaks this summer. The damage was often sporadic, with one tree being heavily infested while neighboring trees had low numbers of galls. Severe infestations of jumping oak gall can cause leaves to turn brown and fall prematurely from trees.



Jumping oak galls are caused by tiny, stingless wasps (*Neuroterus* sp.) that deposit their eggs in oak leaves in the spring. As the eggs hatch and the young wasp larvae begin feeding, the leaf tissue forms a button-like, pinhead-sized gall around each larva on the underside of the leaf. Most galls drop from the leaves in early summer. These fallen galls often "jump" due to vigorous movements of the larvae within, much like moth larvae of Mexican jumping beans. This behavior allows the galls to fall deeper into leaf litter and soil where they are sheltered throughout the coming winter.

Jumping oak gall wasps are present every year but often go unnoticed. The last major outbreak of this native species occurred across much of Missouri in 2010. Although entire tree crowns can turn brown, the infestation is rarely fatal to trees. For more information, see the **Jumping Oak Gall Forest Health Alert**.

Heavy infestation of jumping oak gall on white oak, resulting in distorted, scorched foliage. *Photo: MDC*

New Brochure: Don’t move firewood!

In 2019, the Missouri Department of Conservation used funding provided by the USDA to create a new brochure to help discourage the long-distance movement of firewood in Missouri. This brochure features a piece of firewood and the potential tree-killing pests that can be transported in or on it. Copies are available through the Forest Health Program staff at the Missouri Department of Conservation.

Missouri is currently under a statewide quarantine that restricts the movement of hardwood firewood out of the state as well as the importation of hardwood firewood from some states (check with the **Missouri Dept. of Agriculture** for details). At this time, it is legal to move firewood within the state, but officials strongly recommend not moving firewood more than 50 miles from where it was harvested to reduce the risk of spreading invasive pests. **Moving firewood less than 10 miles from its origin is best.** For more information, visit **treepests.missouri.edu** and **DontMoveFirewood.org**.

"What's in your firewood" infographic from the new Don’t Move Firewood brochure. *Photo: MDC*

Questions? Contact your local Forester with the Missouri Department of Conservation.

Find contact information for your county at:

mdc.mo.gov

The Missouri Department of Conservation is an equal opportunity provider.

An electronic copy of this document can be found at **mdc.mo.gov** by searching “forest health news.”

This project was funded in whole or in part through a grant awarded by the USDA, Forest Service, Northeastern Area State and Private Forestry. The USDA is an equal opportunity provider and employer.